

**AMENDMENTS TO THE CLAIMS:**

All pending claims are set forth below. Cancelled and withdrawn claims are indicated with claim number and status only. The claims as listed below show added text with underlining and deleted text with ~~striketrough~~. The status of each claim is indicated with one of (original), (currently amended), (cancelled), (withdrawn), (new), (previously presented), and (not entered). Please AMEND claims 1, 2, 9-13, 17-19, 22-23, and 27-29 and ADD new claims 34-39 in accordance with the following:

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1. (currently amended) An electrolyte for a lithium-sulfur battery having a positive and a negative electrode, comprising:
  - a first component solvent with a sulfur solubility greater than or equal to 20 mM;
  - a second component solvent with a sulfur solubility less than 20 mM and greater than 0.5 mM;
  - a third component solvent with a high dielectric constant and a high viscosity; and
  - an electrolyte salt.
2. (currently amended) The electrolyte for the lithium-sulfur battery of claim 1, wherein said first component solvent is ~~roughly~~ substantially between 5% and 30% by volume of the electrolyte,  
said second component solvent is ~~roughly~~ substantially between 20% and 70% by volume of the electrolyte, and  
said third component solvent is ~~roughly~~ substantially between 20% and 70% by volume of the electrolyte.
3. (original) The electrolyte for the lithium-sulfur battery of claim 1, wherein a difference in sulfur solubility between said first component solvent and said second component solvent is more than 20mM.
4. (original) The electrolyte for the lithium-sulfur battery of claim 1, wherein said second component solvent and said third component solvent are mixed in a ratio of 1:1.
5. (original) The electrolyte for the lithium-sulfur battery of claim 1, wherein said first component solvent is at least one selected from a group consisting of benzene, fluorobenzene, toluene, trifluorotoluene, xylene, cyclohexane, tetrahydrofurane, and 2-methyl tetrahydrofurane.

6. (original) The electrolyte for the lithium-sulfur battery of claim 1, wherein said second component solvent is at least one selected from a group consisting of cyclohexanone, ethanol, isopropanol, dimethyl carbonate, ethylmethyl carbonate, diethyl carbonate, methylpropyl carbonate, methyl propionate, ethyl propionate, methyl acetate, ethyl acetate, propyl acetate, dimethoxy ethane, 1,3-dioxolane, diglyme (2-methoxyethyl ether), and tetraglyme.

7. (original) The electrolyte for the lithium-sulfur battery of claim 1, wherein said third component solvent is at least one selected from a group consisting of ethylene carbonate, propylene carbonate,  $\gamma$ -butyrolactone, and sulforane.

8. (original) The electrolyte for the lithium-sulfur battery of claim 1, further comprising an additive gas which forms a solid electrolyte interface (SEI) at a surface of the negative electrode during charging.

9. (currently amended) The electrolyte for the lithium-sulfur battery of claim 8 35, wherein said additive gas is at least one selected from a group consisting of CO<sub>2</sub>, SO<sub>2</sub> and N<sub>2</sub>O.

10. (currently amended) The electrolyte for the lithium-sulfur battery of claim 8 35, wherein said additive gas is ~~roughly~~ substantially between 0.2% and 10% by weight of the electrolyte.

11. (currently amended) The electrolyte for the lithium-sulfur battery of claim 1, wherein said electrolyte salt is at least one selected from a group consisting of lithium hexafluorophosphate (~~LiPF<sub>6</sub>~~), lithium tetrafluoroborate (~~LiBF<sub>4</sub>~~), lithium hexafluoroarsenate (~~LiAsF<sub>6</sub>~~), lithium perchlorate (~~LiClO<sub>4</sub>~~), lithium trifluoromethane sulfonylimide (~~LiN(CF<sub>3</sub>SO<sub>2</sub>)<sub>2</sub>~~), and lithium trifluorosulfonate (~~CF<sub>3</sub>SO<sub>3</sub>Li~~).

12. (currently amended) The electrolyte for the lithium-sulfur battery of claim 11, wherein a concentration of said electrolyte salt is ~~roughly~~ substantially between 0.5 M and 2.0 M.

13. (currently amended) A lithium-sulfur battery comprising:  
a negative electrode comprising a negative active material selected from a group consisting of lithium metal, lithium-containing alloy, a combination electrode of lithium/inactive sulfur, a

compound that ~~can~~ reversibly intercalates a lithium ion, and a compound that ~~can~~ reversibly redoxides with the lithium ion at a surface;

an electrolyte comprising:

a first component solvent with a sulfur solubility greater than or equal to 20 mM;[[,]]

a second component solvent with a sulfur solubility less than 20 mM and greater than 0.5 mM;[[,]]

a third component solvent with a high dielectric constant and a high viscosity, and an electrolyte salt; and

a positive electrode comprising a positive active material comprising at least one sulfur-based material selected from a group consisting of sulfur element,  $\text{Li}_2\text{S}_n$  ( $n \geq 1$ ), organic sulfur compound and carbon-sulfur polymer  $((\text{C}_2\text{S}_x)_n$  where  $x=2.5$  to 50 and  $n \geq 2$ ), and electrically conductive material.

14. (original) An electrolyte for use in a lithium-sulfur battery, comprising:  
a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;  
a high dielectric solvent having a high dielectric constant; and  
an electrolyte salt.

15. (original) The electrolyte of claim 14, wherein said mixture comprises first and second solvents, wherein a relative amount of the first and second solvents is determined in accordance with a relative amount of the sulfur and the sulfur compounds.

16. (original) The electrolyte of claim 15, wherein a relative amount of the second solvent and said high dielectric solvent is determined in accordance with the dielectric constants and viscosities of the second solvent and said high dielectric solvent.

17. (currently amended) The electrolyte of claim 14, wherein said mixture comprises a first solvent with a sulfur solubility greater than or equal to 20 mM and a second solvent with a sulfur solubility less than 20 mM and greater than 0.5 mM.


18. (currently amended) The electrolyte of claim 17, wherein:  
the first solvent is ~~roughly~~ substantially between 5% and 30% by volume of the electrolyte,  
the second solvent is ~~roughly~~ substantially between 20% and 70% by volume of the

electrolyte, and

said high dielectric solvent is ~~roughly~~ substantially between 20% and 70% by volume of the electrolyte.

19. (currently amended) The electrolyte of claim 17, wherein ~~the~~ a difference in the sulfur solubility between the first solvent and the second solvent is more than 20mM.

20. (original) The electrolyte of claim 14, wherein one of the solvents of said mixture is at least one selected from a group consisting of benzene, fluorobenzene, toluene, trifluorotoluene, xylene, cyclohexane, tetrahydrofuran, and 2-methyl tetrahydrofuran.



21. (original) The electrolyte of claim 14, wherein one of the solvents of said mixture is at least one selected from a group consisting of cyclohexanone, ethanol, isopropanol, dimethyl carbonate, ethylmethyl carbonate, diethyl carbonate, methylpropyl carbonate, methyl propionate, ethyl propionate, methyl acetate, ethyl acetate, propyl acetate, dimethoxy ethane, 1,3-dioxolane, diglyme (2-methoxyethyl ether), and tetraglyme.

22. (currently amended) The electrolyte of claim 14, wherein said high dielectric solvent is at least one selected from a group consisting of ethylene carbonate, propylene carbonate,  $\gamma$ -butyrolactone, and sulforane.

23. (currently amended) A lithium-sulfur battery, comprising:  
a negative electrode comprising a negative active material;  
an electrolyte comprising:  
a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;[[,]]  
a high dielectric solvent having a high dielectric constant;[[,]] and  
an electrolyte salt; and  
a positive electrode comprising a positive active material.


24. (original) The battery of claim 23, wherein said electrolyte further comprises an additive to prevent the formation of dendrite on a surface of said negative electrode.

25. (original) The battery of claim 23, wherein said electrolyte further comprises an

additive to form a solid electrolyte interface on a lithium metal surface of said negative electrode.

26. (original) The battery of claim 23, wherein the mixture comprises first and second solvents, where a relative amount of the first and second solvents is determined in accordance with a relative amount of the sulfur and the sulfur compounds.

27. (original) The battery of claim 26, wherein a relative amount of the second solvent and the high dielectric solvent is determined in accordance with the dielectric constants and viscosities of the second solvent and the high dielectric solvent.



28. (currently amended) The battery of claim 23, wherein the mixture comprises a first solvent with a sulfur solubility greater than or equal to 20 mM and a second solvent with a sulfur solubility less than 20 mM and greater than 0.5 mM.

29. (currently amended) The battery of claim 28, wherein:  
the first solvent is ~~roughly~~ substantially between 5% and 30% by volume of said electrolyte,  
the second solvent is ~~roughly~~ substantially between 20% and 70% by volume of said electrolyte, and  
the high dielectric solvent is ~~roughly~~ substantially between 20% and 70% by volume of said electrolyte.

30. (original) The battery of claim 28, wherein the difference in the sulfur solubility between the first solvent and the second solvent is more than 20 mM.

31. (original) The battery of claim 23, wherein one of the solvents of the mixture is at least one selected from a group consisting of benzene, fluorobenzene, toluene, trifluorotoluene, xylene, cyclohexane, tetrahydrofuran, and 2-methyl tetrahydrofuran.

32. (original) The battery of claim 23, wherein one of the solvents of the mixture is at least one selected from a group consisting of cyclohexanone, ethanol, isopropanol, dimethyl carbonate, ethylmethyl carbonate, diethyl carbonate, methylpropyl carbonate, methyl propionate, ethyl propionate, methyl acetate, ethyl acetate, propyl acetate, dimethoxy ethane, 1,3-dioxolane, diglyme (2-methoxyethyl ether), and tetraglyme.

33. (original) The battery of claim 23, wherein the high dielectric solvent is at least one selected from a group consisting of ethylene carbonate, propylene carbonate,  $\gamma$ -butyrolactone, and sulforane.

34. (new) An electrolyte for a lithium-sulfur battery having a positive and a negative electrode, comprising:

a first component solvent with a sulfur solubility greater than or equal to 20 mM;

a second component solvent with a sulfur solubility less than 20 mM and greater than 0.5 mM;

a third component solvent having a high dielectric constant and a high viscosity and an electrolyte salt,

wherein

said first component solvent is substantially between 5% and 30% by volume of the electrolyte,

said second component solvent is substantially between 20% and 70% by volume of the electrolyte, and

said third component solvent is substantially between 20% and 70% by volume of the electrolyte.

35. (new) An electrolyte for a lithium-sulfur battery having a positive and a negative electrode, comprising:

a first component solvent with a sulfur solubility greater than or equal to 20 mM;

a second component solvent with a sulfur solubility less than 20 mM and greater than 0.5 mM;

a third component solvent having a high dielectric constant and a high viscosity;

an electrolyte salt; and

an additive gas which forms a solid electrolyte interface (SEI) at a surface of the negative electrode during charging.

36. (new) An electrolyte for use in a lithium-sulfur battery, comprising:

a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;

a solvent having a high dielectric constant; and

an electrolyte salt,

wherein said mixture comprises:

a first solvent with a sulfur solubility greater than or equal to 20 mM; and

a second solvent with a sulfur solubility less than 20 mM and greater than 0.5 mM,

and


wherein:

the first solvent is substantially between 5% and 30% by volume of the electrolyte,

the second solvent is substantially between 20% and 70% by volume of the

electrolyte, and

the solvent having a high dielectric constant is substantially between 20% and 70% by volume of the electrolyte.



37. (new) A lithium-sulfur battery, comprising:

a negative electrode comprising a negative active material;

an electrolyte comprising:

a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;

a solvent having a high dielectric constant; and

an electrolyte salt; and

a positive electrode comprising a positive active material,

wherein said electrolyte further comprises an additive to prevent the formation of dendrite on a surface of said negative electrode.

38. (new) A lithium-sulfur battery, comprising:

a negative electrode comprising a negative active material;

an electrolyte comprising:

a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;

a solvent having a high dielectric constant;

an electrolyte salt; and

an additive to form a solid electrolyte interface on a lithium metal surface of said negative electrode; and

a positive electrode comprising a positive active material.

39. (new) A lithium-sulfur battery, comprising:

a negative electrode comprising a negative active material;

an electrolyte comprising:

a mixture of solvents having different sulfur solubilities to dissolve sulfur and sulfur compounds, the sulfur compounds having a higher polarity than a polarity of the sulfur;

a solvent having a high dielectric constant; and

an electrolyte salt; and

a positive electrode comprising a positive active material,

wherein the mixture comprises:

a first solvent with a sulfur solubility greater than or equal to 20 mM; and

a second solvent with a sulfur solubility less than 20 mM and greater than 0.5 mM,

and

wherein:

the first solvent is substantially between 5% and 30% by volume of said electrolyte,

the second solvent is substantially between 20% and 70% by volume of said

electrolyte, and

the solvent having the high dielectric constant is substantially between 20% and 70% by volume of said electrolyte.